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(54) Plant-promoting preparations
with controlled-start plant-promoting
agent release

(57) Plant-promoting preparations
with controlled-start plant-promoting
agent release, especially fertiliser pre-
parations with controlled-start nutrient
release, characterised in that the prepa-
rations containing the plant-promoting
agent enveloped in an enveloping
agent selected from water-repellent
substances, substances that are spar-
ingly soluble in water and substances
capable of swelling in water.

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SPECIFICATION

Plant-promoting preparations with controlled-start plant-promoting agent release

- 5 The present invention is concerned with plant-promoting preparations with controlled-start plant-promoting agent release, especially fertiliser preparations with controlled-start nutrient release, and with their use. As is known, fertilisers are substances intended to be fed to cultivated plants in order to promote their growth, increase their yield, or improve their quality.
- 10 All known solid fertiliser preparations make nutrients available to the plants by way of the soil and/or substrate solution according to the speed with which they dissolve. The state of the art is to control the speed at which they dissolve in such a way that the nutrients can flow uniformly according to the composition of the fertiliser preparation during a selected period of time, from the time of application onwards.
- 15 A common factor with all these fertilisers, however, is that the start of the nutrient release cannot be controlled, so that fast-acting fertilisers release the whole of the amount of the nutrients immediately and the slow-acting fertilisers liberate a part of the amount of the nutrients immediately. For physiological, ecological and economic reasons it is desirable and/or necessary to increase the utilisation of fertiliser preparations, and thus their effectiveness, in such a way that with a single high total outlay and thus with the lowest possible application cost both phytotoxicity and pollution due to leaching-out losses are avoided or at least reduced to a great extent.
- 20 The problem upon which the present invention is based has therefore been to provide a fertiliser preparation which makes the nutrients available only at a desired time and in the required amounts. This problem is now solved according to the present invention by the preparations, as defined below.
- 25 The present invention provides a plant-promoting preparation which comprises a plant-promoting agent enveloped in an enveloping agent, the enveloping agent being selected from water-repellent substances, substances that are sparingly soluble in water and substances capable of swelling in water.
- The new preparations have a delayed-start promoting agent release the time of which can be controlled according to the desired purpose for which they are used by the choice of the enveloping agent.
- The plant-promoting agent in the preparations of the present invention may be a fertiliser or a plant treatment agent. Preparations containing fertilisers are, however, a preferred embodiment of the preparations of the present invention.
- 30 Particular embodiments of the plant-promoting preparations of the present invention are that: the plant-promoting agent is a mineral single nutrient fertiliser, a mineral fertiliser containing two or more nutrients, an organo-mineral fertiliser, an organic fertiliser, a trace nutrient or a plant treatment agent or a combination of two or more such substances, the plant-promoting agent is a fertiliser in the form of a powder, a crystalline fertiliser, a granular fertiliser, a fertiliser in the form of coated granules, a fertiliser in the form of rod-shaped pellets, an encapsulated fertiliser solution or an encapsulated fertiliser suspension, the plant-promoting agent is a fertiliser containing at least one nutrient selected from the elements carbon, oxygen, nitrogen, phosphorus, potassium, magnesium, calcium, sulphur, iron, manganese, copper, zinc, chlorine, boron, molybdenum, sodium, silicon, cobalt and aluminium, the or each element preferably being present in the form of a compound, the enveloping agent is at least one water-repellent substance selected from paraffins, waxes, metal soaps, quaternary ammonium compounds, urea derivatives, fatty acid-modified resins, silicones and perfluorinated organic compounds, the water-repellent substance is iron palmitate, the enveloping agent is a substance that is sparingly soluble in water or capable of swelling in water, the substance being a polymer containing water-wettable groups, the water-wettable groups are hydroxyl, carboxyl, alkyl ester, cyano, chloro or fluoro groups, such polymers that are sparingly soluble in water or capable of swelling in water are polyvinyl alcohols, preferably containing a residual acetyl content of 10%, the enveloping agent is a substance that is sparingly soluble in water, the substance being an inorganic compound, such an inorganic compound that is sparingly soluble in water is iron phosphate or calcium phosphate, the enveloping agent is (i) a substance that is sparingly soluble in water or capable of swelling in water, the substance being a polymer containing water-wettable groups or an inorganic compound, and (ii) at least one water-repellent substance selected from paraffins, waxes, metal soaps, quaternary ammonium compounds, urea derivatives, fatty acid-modified resins, silicones and perfluorinated organic compounds, the enveloping agent is a water-repellent substance, the layer of the water-repellent substance surrounding the plant-promoting agent having a thickness within the range of from 10^{-8} to 10^{-2} m, preferably from $1 \cdot 10^{-6}$ m to $2 \cdot 10^{-3}$ m, the enveloping agent is a substance that is sparingly soluble in water or capable of swelling in water, the layer of the enveloping agent surrounding the plant-promoting agent having a thickness within the range of from 10^{-6} m to 10^{-2} m, preferably from $5 \cdot 10^{-6}$ m to $2 \cdot 10^{-3}$ m.
- 55 The fertiliser preparations according to the present invention have, surprisingly, a nutrient release which starts after a time lag and the start of which can be controlled according to the desired purpose by the choice of an appropriate enveloping agent, so that the flow of nutrients does not begin until a delay time of, for example, for 1 day to 2 years, preferably from 30 to 180 days, has elapsed.
- 60 The enveloping agent may thus be a substance capable of releasing the plant-promoting agent, for example a fertiliser, within a period of from 1 day to 2 years, preferably from 30 to 180 days, after the preparation of the present invention has been introduced into soil.
- 65 Many advantages which cannot be obtained by the use of the hitherto known fertiliser preparations result

from this controlled nutrient release.

Thus, for example, fertilising can be carried out according to actual requirements, with the nutrient release being adjusted to meet the peak requirement and the zero requirement of the plants, and this is not possible with any of the previously known fertilisers.

- 5 By this means the varying nutrient requirements of plants during a cultivation period can be met to the optimum, this of course being an advantage; thus damage to the plants due to over-fertilising during periods of high plant sensitivity, or insufficient growth due to an inadequate supply of nutrients when requirements are at a maximum can be avoided. 5

- 10 The enveloping agent may thus be a substance capable of controlling the release of the plant-promoting agent, for example a fertiliser, in a way suited to the nutrient requirements of the plant to be treated with the preparations of the present invention, so that over-fertilising and/or unacceptable leaching-out losses are avoided. 10

- 15 The liberation of the nutrient supply which can be controlled by means of the fertiliser preparations according to the present invention also offers the advantage of fully realising the yield potential of plants even under unfavourable climatic conditions or on soils with poor fertility, thus opening up avenues for high performance fertilising which were previously not possible. 15

- 20 Furthermore, the liberation of the nutrient flow which can be controlled by means of the fertiliser preparations according to the present invention offers the possibility of satisfying to an optimum degree the changing demands with regard to nutrient forms and their concentration for a special cultivation by means of a single total quantity of fertiliser applied at sowing time or when potting, so that risky follow-up fertilising, which is ineffective when carried out at the wrong time, can be omitted. 20

- 25 The liberation of the nutrient supply which can be controlled by means of the fertiliser preparations according to the present invention also offers the possibility of adding fertilisers to substrates long before the latter are used, without having to take into account high salt contents that are already active when use is commenced, since they are first activated by watering of the substrates when their use commences, so that salt shock and/or salt damage can be avoided. 25

Thus, the enveloping agent may be a substance capable of releasing the plant-promoting agent, for example a fertiliser, after watering of a substrate to which the preparation of the present invention has been added.

- 30 The following fertilisers may be used as the plant-promoting agent in accordance with the present invention: 30

- fertiliser powders
- crystalline fertilisers
- granular fertilisers

- 35 -granular coated fertilisers
-fertilisers in the form of rod-shaped pellets
-encapsulated fertiliser solutions or suspensions. 35

The above-mentioned fertilisers may be:

- 40 - mineral single nutrient fertilisers
- mineral multi-nutrient fertilisers
- organo-mineral fertilisers
- organic fertilisers
- trace nutrients
- combinations of the above-mentioned components. 40

- 45 As the plant-promoting agent there may also be used fertilisers that have been subjected to any pre-treatment, for example fertilisers with a retarded release of the plant nutrients, among which sparingly soluble salts, polymeric nutrient compounds and nutrients chemically or physically bound to natural and synthetic carriers may be mentioned by way of example. 45

- 50 The present invention also provides a method of promoting the development of a living plant, wherein the area in the vicinity of the living plant is treated with a preparation of the present invention. 50

- The present invention further provides a method of promoting the development of crop plants in a crop area, wherein the crop area is treated with a preparation of the present invention. As indicated above, a single treatment of the crop area may be carried out at the start of the crop plants' growth with an amount of the preparation that is sufficient for the crop plants until they are fully developed; another possibility is for the treatment to be carried out before the crop plants are sown in the crop area. 55

The present invention further provides a pack which comprises a preparation of the present invention, together with instructions for its use for promoting the development of plants.

- 60 The present invention further provides a process for the manufacture of a preparation of the present invention, wherein in a suitable apparatus a plant-promoting agent is enveloped sufficiently uniformly with a layer having a suitable thickness of an enveloping agent, the enveloping agent being selected from water-repellent substances, substances that are sparingly soluble in water and substances capable of swelling in water. 60

- This process of the present invention may be carried out in a manner known *per se*, for example, by placing the plant-promoting agent, especially a fertiliser in which the nutrient release is to be influenced according to the present invention, in an apparatus suitable for the type of treatment in question, for 65

example in a rotating drum, a granulating vessel or a revolving coating apparatus, and adding the appropriate treatment agent thereto in such a way that the plant-promoting agent is enveloped completely and in a sufficiently uniform manner to the desired layer thickness, or by placing the appropriate treatment agent in a suitable apparatus, for example in a rotating drum or a granulating vessel, and introducing the plant-promoting agent, especially a fertiliser in which the nutrient release is to be influenced according to the present invention, in such a way that the plant-promoting agent is enveloped completely and in a sufficiently uniform manner to the desired layer thickness.

As the water-repellent substances, substances that are sparingly soluble in water and substances capable of swelling in water from which the enveloping agent is selected, there may be mentioned in particular those listed in the following Table.

Table I

	Paraffins, advantageously with a melting range between 40 and 250°C, preferably hard paraffin with a melting range of more than 55°C;	
15	waxes, for example beeswax, spermaceti and carnauba wax; metal soaps, for example Mg-, Ca-, Fe-, Cu-, Zn-, Mn-, Zr- or Al-salts of lauric acid, myristic acid, palmitic acid, stearic acid or oleic acid, preferably Mg-, Ca-, Fe-, Al- or Zr-salts of palmitic acid;	15
	quaternary ammonium compounds, for example octadecyloxy- methylpyridinium chloride or N-methyl-N-stearoylamido- methylenepyridinium chloride;	
20	fatty acid-modified synthetic resins, for example condensates of monododecylurea-formaldehyde-preconcentrate or hexamethylolmelamine ether modified with lauric acid, palmitic acid and/or stearic acid; urea derivatives, for example octadecylethyleneurea; melamine derivatives; polysiloxanes, for example hydrogen methyl polysiloxane and dimethyl polysiloxane;	20
	fluorocarbon polymerisates, for example 1,1-dihydro-perfluorooctyl-polyacrylic acid ester;	
25	alginates, for example potassium alginate; gelatins;	25
	casine;	
	polysaccharides, for example starch, lactose, cellulose, cellulose derivatives, for example ethyl cellulose, hydroxypropyl cellulose and mixtures thereof, pectins and xanthans;	
	polyvinyl alcohols;	
30	polyvinyl acetates;	30
	polyvinyl ethers;	
	polyvinyl pyrrolidones;	
	polyacrylates;	
	clay minerals, for example bentonite, illite and attapulgite;	
35	metal oxides, for example iron oxide hydrate and magnesium oxide;	35
	metal phosphates, for example calcium phosphate and iron phosphate;	
	polyphosphates, for example Kurrol's salt and metal silicates, for example potash water glass (potassium silicate).	

Of the substance listed in Table I there are preferably used as the enveloping agent partially saponified polyvinyl acetates, gelatins, iron oxide hydrates and calcium phosphate.

The layer of enveloping agent is generally applied in a thickness of from 10^{-8} m to 10^{-2} m, especially from $1 \cdot 10^{-6}$ m to $2 \cdot 10^{-3}$ m.

The plant-promoting preparations of the present invention may be applied alone, or in solution or as an emulsion and also combined with other substances as part of multi-component systems.

The following Examples illustrates the invention:

Example 1

237.5g of an NPK-synthesized granulate having a nutrient composition of 13-13-21 and a particle size range of from 2.0 - 4.0 mm were heated to 100° - 110°C with hot air in a rotating drum. With hot air continuing to be introduced, there was added to the granules a total of 48 g of a 26% strength suspension consisting of 9 parts of a binding agent based on an oil-modified alkyd resin with 1 part of iron palmitate in a solvent mixture composed of 1 part of benzine having a boiling range of from 130 to 220°C and 2 parts of xylene, in such a way that the dosing and drying rates of the suspension were the same. When the treatment had been completed, the granules were slowly cooled to room temperature.

Example 2

475 g of an NPK-chip granulate produced with 100 g of a 50% strength alkyd resin solution and having a nutrient composition of 18-4.5-9-0.9 MgO-0.1 Fe and having a particle size range of from 3.0 to 5.0 mm were heated to 50-60° with hot air in a coating drum. With the flow of hot air being maintained (500 l/minute), there was added to the granules a total of 250 g of a 10% aqueous polyvinyl alcohol solution (residual acetyl content approximately 10%, viscosity at 20°C approximately 35 mPas) in such a way that the dosing and drying rates of the solution were the same. When the treatment had been completed, slow cooling to room temperatures was carried out.

Example 3

425 g of a fertiliser produced from 383 g of an NPK-chip granulate and 85 g of a 50% strength alkyd resin solution and having a nutrient composition of 18-4.5-9-0.9 Mg0-0.1 Fe and having a particle size range of from 3.0 to 5.0 mm were heated to 50 to 60°C by hot air in a coating drum having a perforated base. With the flow of hot air being maintained, there was slowly added to the granules a total of 500 g of a 10% aqueous polyvinyl alcohol solution (residual acetyl content approximately 10%, viscosity at 20°C approximately 35 mPas), in such a way that the dosing and drying rates of the solution were the same. After this coating had been completed, the granules were heated to 110 to 120°C and 25 g of a pre-cross-linked methylsiloxane-hardener mixture were added thereto in such a way that the dosing and hardening rates of the mixtures were again the same. When the treatment had been completed, the product was slowly cooled to room temperature.

The following Examples illustrate the use of fertiliser preparations according to the present invention and their effects as compared with known agents.

Example 4

The time-dependent nutrient release characteristics of the fertiliser granules identified in the Table below in water were determined by continuous measurement of the conductivity of the dissolved salts accumulating in the water. The results are listed in the Table.

Time	Granules treated with alkyd resin	Granules treated according to Example 3
(min)	($\mu\text{S/cm}$)	($\mu\text{S/cm}$)
0	0	0
2	29	0
4	58	0
6	87	0
8	107	0
10	123	1
12	134	1
14	142	2
16	149	2
18	156	3
20	163	3
22	169	4
24	175	7
26	180	12
28	185	20
30	190	31

Example 5

The time-dependent nutrient release characteristics of the fertiliser granules identified in the Table below in a substrate were determined by measurement of single cut yields of meadow grass dry matter over a period of 80 days after a single application of depressively-acting fertiliser mixed into the substrate before the meadow grass was sown. The results are listed in the Table.

(The control value used to obtain the results listed in the Table: the measurement taken with a substrate having a good natural nutrient supply without depressively-acting fertiliser mixed in was taken as equal to 100%).

Time between sowing date and cutting date	NPK-fertiliser 13-13-21		
	without after-treatment	with alkyd resin treatment	treated according to invention as in Example 3
(days)	%	%	%
15	0.5	22	74
30	8	49	109
50	43	111	191
80	72	188	312

CLAIMS

1. A plant-promoting preparation which comprises a plant-promoting agent enveloped in an enveloping agent, the enveloping agent being selected from water-repellent substances, substances that are sparingly soluble in water and substances capable of swelling in water.
2. A preparation as claimed in claim 1, wherein the plant-promoting agent is a fertiliser.
3. A preparation as claimed in claim 1, wherein the plant-promoting agent is a mineral single nutrient fertiliser, a mineral fertiliser containing two or more nutrients, an organo-mineral fertiliser, an organic fertiliser, a trace nutrient or a plant treatment agent or a combination of two or more such substances.
4. A preparation as claimed in claim 2, wherein the plant-promoting agent is a fertiliser containing at least one nutrient selected from the elements carbon, oxygen, nitrogen, phosphorus, potassium, magnesium, calcium, sulphur, iron, manganese, copper, zinc, chlorine, boron, molybdenum, sodium, silicon, cobalt and aluminium.
5. A preparation as claimed in claim 4, wherein the or each element is present in the form of a compound.
6. A preparation as claimed in claim 2, wherein the plant-promoting agent is a fertiliser in the form of a powder, a crystalline fertiliser, a granular fertiliser, a fertiliser in the form of coated granules, a fertiliser in the form of rod-shaped pellets, an encapsulated fertiliser solution or an encapsulated fertiliser suspension.
7. A preparation as claimed in any one of claims 1 to 6, wherein the enveloping agent is at least one water-repellent substance selected from paraffins, waxes, metal soaps, quaternary ammonium compounds, urea derivatives, fatty acid-modified resins, silicones and perfluorinated organic compounds.
8. A preparation as claimed in claim 7, wherein the enveloping agent is iron palmitate.
9. A preparation as claimed in any one of claims 1 to 6, wherein the enveloping agent is a substance that is sparingly soluble in water, the substance being a polymer containing water-wettable groups.
10. A preparation as claimed in any one of claims 1 to 6, wherein the enveloping agent is a substance capable of swelling in water, the substance being a polymer containing water-wettable groups.
11. A preparation as claimed in claim 9 or 10, wherein the water-wettable groups are hydroxyl, carboxyl, alkyl ester, cyano, chloro or fluoro groups.
12. A preparation as claimed in any one of claims 9 to 11, wherein the polymer is polyvinyl alcohol.
13. A preparation as claimed in claim 12, wherein the polyvinyl alcohol contains a residual acetyl content of 10%.
14. A preparation as claimed in any one of claims 1 to 6, wherein the enveloping agent is a substance that is sparingly soluble in water, the substance being an inorganic compound.
15. A preparation as claimed in claim 14, wherein the inorganic compound is iron phosphate or calcium phosphate.

16. A preparation as claimed in any one of claims 1 to 6, wherein the enveloping agent is (i) a substance that is sparingly soluble in water or capable of swelling in water, the substance being a polymer containing water-wettable groups or an inorganic compound, and (ii) at least one water-repellent groups or an inorganic compound, and (ii) at least one water-repellent substance selected from paraffins, waxes, metal soaps, quaternary ammonium compounds, urea derivatives, fatty acid-modified resins, silicones and perfluorinated organic compounds. 5
17. A preparation as claimed in any one of claims 1 to 6, wherein the enveloping agent is any one of the substances listed in Table I herein.
18. A preparation as claimed in any one of claims 1 to 7, wherein the enveloping agent is a water-repellent substance, the layer of the water-repellent substance surrounding the plant-promoting agent 10 having a thickness within the range of from 10^{-8} m to 10^{-2} m.
19. A preparation as claimed in claim 18, wherein the thickness is within the range of from $1 \cdot 10^{-6}$ m to $2 \cdot 10^{-3}$ m.
20. A preparation as claimed in any one of claims 1 to 6 and 9 to 15, wherein the enveloping agent is a substance that is sparingly soluble in water or capable of swelling in water, the layer of the enveloping agent 15 surrounding the plant-promoting agent having a thickness within the range of from 10^{-6} m to 10^{-2} m.
21. A preparation as claimed in claim 20, wherein the thickness is within the range of from $5 \cdot 10^{-5}$ m to $2 \cdot 10^{-3}$ m.
22. A preparation as claimed in any one of claims 1 to 21, wherein the enveloping agent is a substance capable of releasing the plant-promoting agent within a period of from 1 day to 2 years after the preparation 20 has been introduced into soil.
23. A preparation as claimed in claim 22, wherein the period is from 30 to 180 days after the preparation has been introduced into soil.
24. A preparation as claimed in any one of claims 1 to 21, wherein the enveloping agent is a substance 25 capable of releasing the plant-promoting agent after watering of a substrate to which the preparation has been added.
25. A preparation as claimed in claim 1 and substantially as described in any one of Examples 1 to 3 herein.
26. A process for the manufacture of a plant-promoting preparation as claimed in any one of claims 1 to 25, wherein in a suitable apparatus a plant-promoting agent is enveloped sufficiently uniformly with a layer 30 having a suitable thickness of an enveloping agent, the enveloping agent being selected from water-repellent substances, substances that are sparingly soluble in water and substances capable of swelling in water.
27. A process as claimed in claim 26, conducted substantially as described herein.
28. A process as claimed in claim 26, conducted substantially as described in any one of Examples 1 to 3 35 herein.
29. A method of promoting the development of a living plant, wherein the area in the vicinity of the living plant is treated with a preparation as claimed in any one of claims 1 to 25.
30. A method of promoting the development of crop plants in a crop area, wherein the crop area is 40 treated with a preparation as claimed in any one of claims 1 to 25.
31. A method as claimed in claim 30, wherein a single treatment of the crop area is carried out at the start of the crop plants' growth with an amount of the preparation that is sufficient for the crop plants until they are fully developed.
32. A method as claimed in claim 30, wherein the treatment is carried out before the crop plants are sown 45 in the crop area.
33. A pack which comprises a preparation as claimed in any one of claims 1 to 25, together with instructions for its use for promoting the development of plants. 45